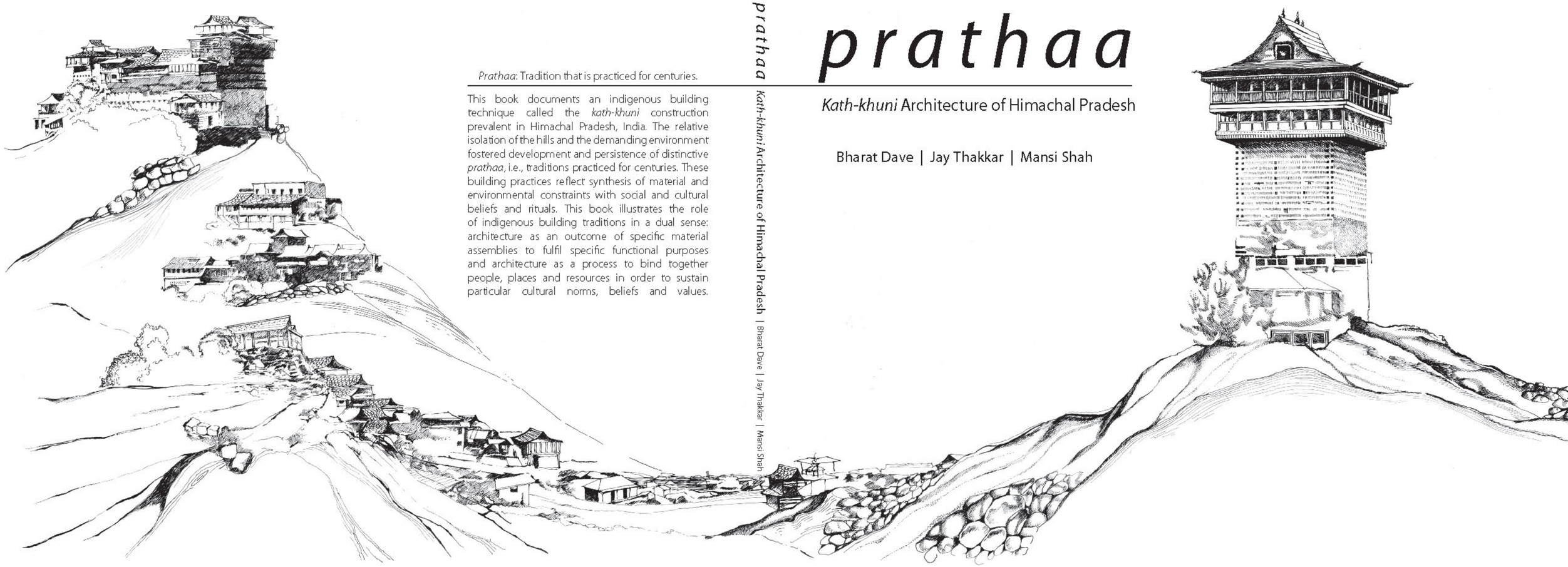

Prathaa: Tradition that is practiced for centuries.

This book documents an indigenous building technique called the *kath-khuni* construction prevalent in Himachal Pradesh, India. The relative isolation of the hills and the demanding environment fostered development and persistence of distinctive *prathaa*, i.e., traditions practiced for centuries. These building practices reflect synthesis of material and environmental constraints with social and cultural beliefs and rituals. This book illustrates the role of indigenous building traditions in a dual sense: architecture as an outcome of specific material assemblies to fulfil specific functional purposes and architecture as a process to bind together people, places and resources in order to sustain particular cultural norms, beliefs and values.

prathaa

Kath-khuni Architecture of Himachal Pradesh | Bharat Dave | Jay Thakkar | Mansi Shah

prathaa

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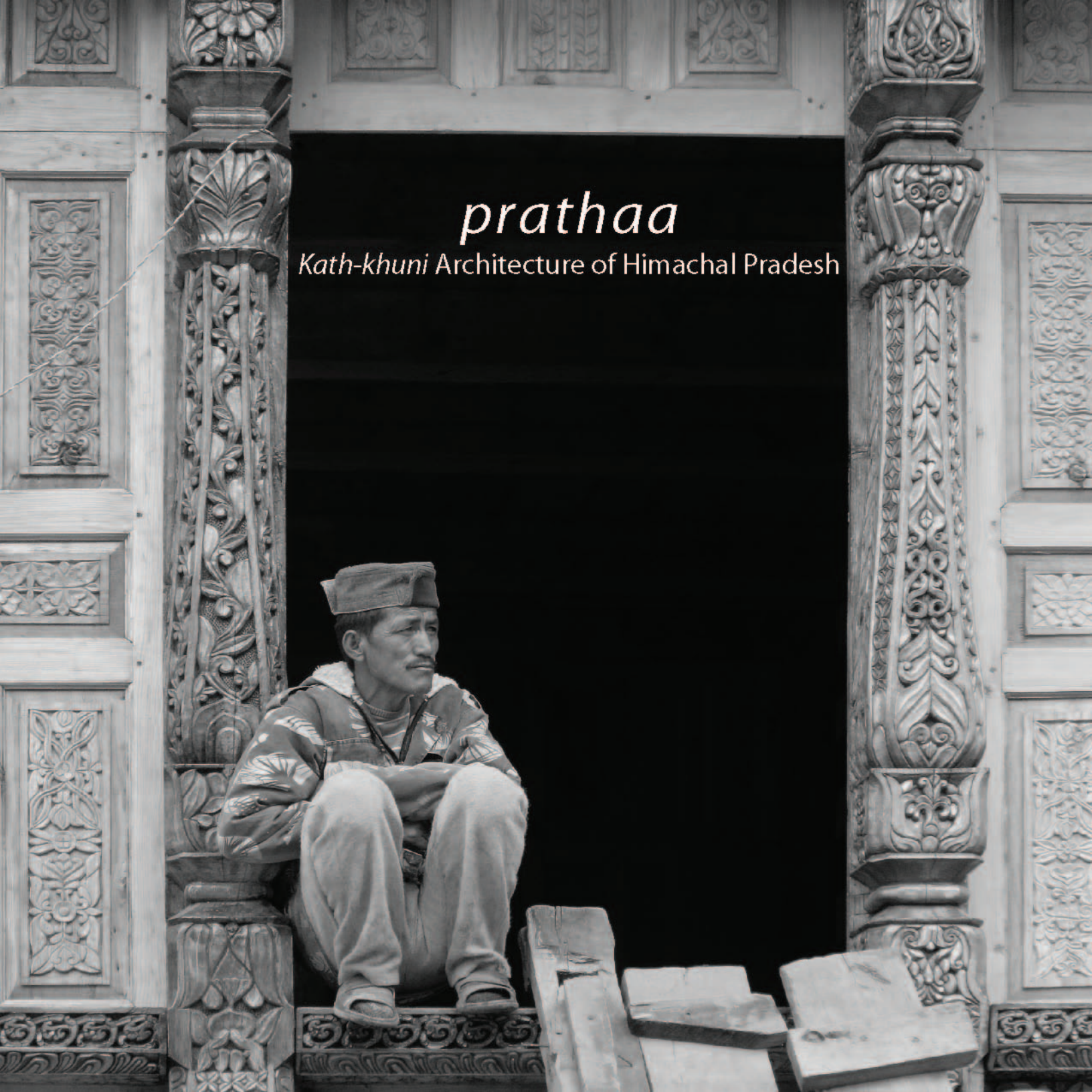
SID Research Cell
School of Interior Design
CEPT University
Ahmedabad, India



prathaa

Kath-khuni Architecture of Himachal Pradesh

prathaa

Kath-khuni Architecture of Himachal Pradesh

Bharat Dave
Jay Thakkar
Mansi Shah

Foreword by Dr. O. C. Handa

SID Research Cell
School of Interior Design
CEPT University
Ahmedabad, India

Authors

Prof. Bharat Dave
Faculty of Architecture, Building & Planning, University of Melbourne, Australia

Prof. Bharat Dave completed doctoral studies at the Swiss Federal Institute of Technology (ETH), Zurich, master's program at the Carnegie Mellon University, Pittsburgh (USA), and undergraduate studies in architecture at the School of Architecture, Ahmedabad (India). Funded by nationally competitive grants, his research revolves around innovative spatial design practices and futures supported by digital technologies.

A/Prof. Jay Thakkar
Design Innovation and Craft Resource Centre (DICRC), Faculty of Design, CEPT University, India

Jay Thakkar is an Assistant Professor at Faculty of Design and Head of Research at Design Innovation and Craft Resource Centre (DICRC) at CEPT University, Ahmedabad, India. He has a Masters in Visual Communication from the Birmingham Institute of Art and Design (BIAD), United Kingdom and a Diploma in Interior Design from the School of Interior Design, CEPT University. Jay Thakkar is a co-author/author and designer of two books 1. "*Matra*: Ways of Measuring Vernacular Built Forms of Himachal Pradesh" (2008) (co-authored with Dr. Skye Morrison) and 2. "*Naqsh*: The Art of Wood Carving of Traditional Houses of Gujarat – Focus on Ornamentation" (2004).

Ar. Mansi Shah
Senior researcher, Design Innovation and Craft Resource Centre (DICRC), CEPT University, India

Mansi Shah is a senior researcher at DICRC, CEPT University, Ahmedabad, India. She completed her Master's degree in 2010 in Urban design at the Domus Academy (Milan, Italy), validated and awarded by the University of Wales, Cardiff, U.K. She completed her undergraduate degree in architecture from South Gujarat University, Surat (India). Her project "Beyond Green" a guerilla idea to promote green movement was displayed during 'Salone del mobile', a design festival in Milan in 2010.

Indigenous Building Practices

3. Location map. Himachal Pradesh is located in the northern part of India along the great Himalayan mountains. It is bordered by the states of Jammu and Kashmir in the north, Punjab in the west and southwest, Haryana and Uttar Pradesh in the south, and Uttarakhand and Tibet in the east.

4. Himachal Pradesh map. Himachal is administratively divided in 12 districts with Shimla as the state capital. The fieldwork was carried out in the Shimla and Kinnaur districts in the south east corners of the state.

14. Typical village settlement along stepped contours. Temple is at the heart of most settlements and usually sited at the highest spot. The surrounding area of the temple is used mainly during festivals and religious gatherings by inhabitants of the particular village.

Settlement patterns

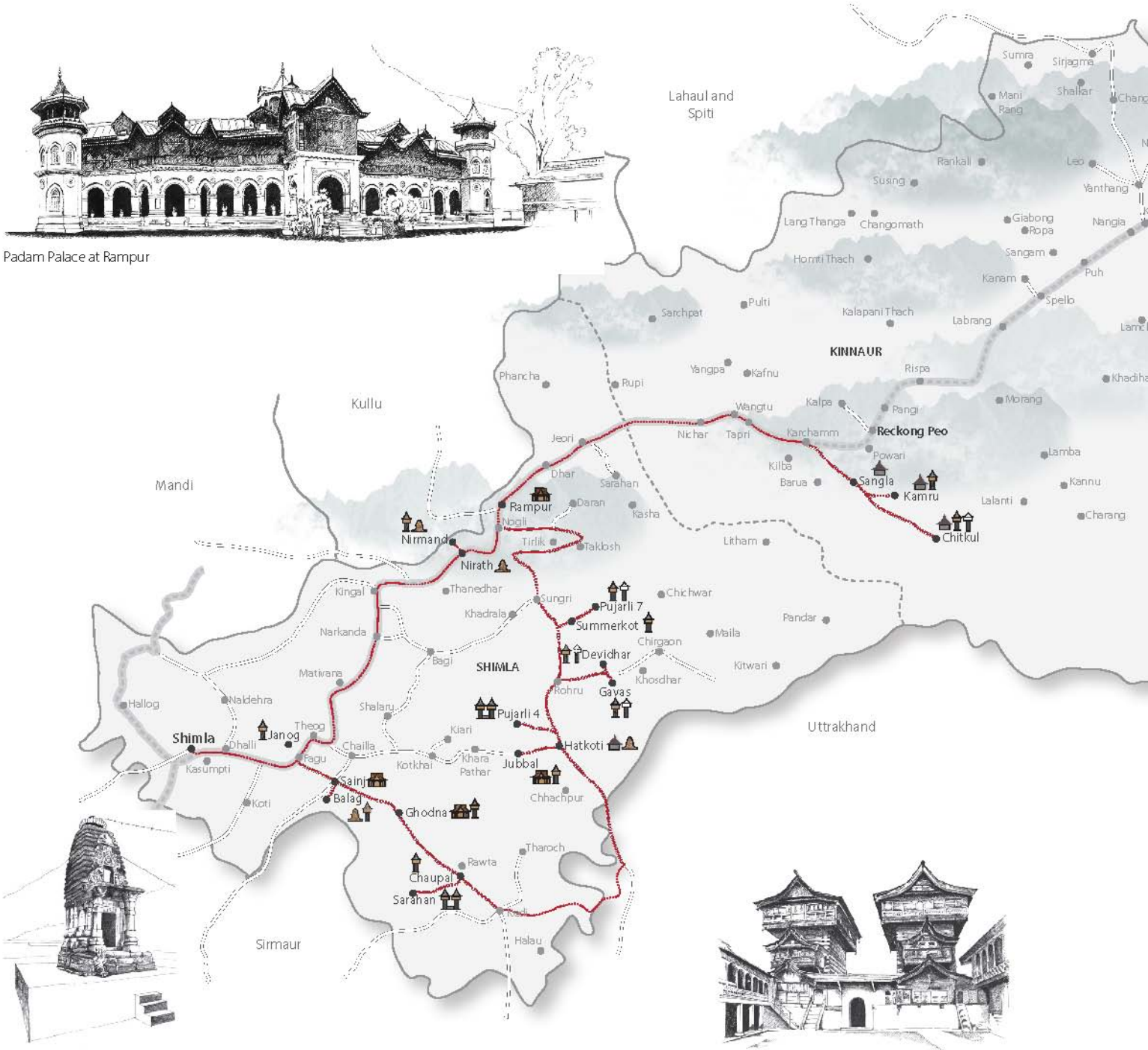
The traditional settlements and villages in the mountains appear to share common characteristics. As noted earlier, they appear to have the 'colour of the land' and appear just right, almost 'ecologically planned'. The landscape, locally available materials, and particular techniques of making and assembling using resources and labour at hand, they all contribute to a common formal language of settlements in Himachal Pradesh.

The settlements appear to be draped along contours of the landscape. This negotiation with slopes (combined with the possibility of soil erosion due to landslides) is an ever present factor in location and growth of settlements in the mountains. Typically located along contoured sunny slopes of hills and mountains, houses and streets in most villages are organised around a primary circulation artery. A village temple is usually found along this primary movement spine with an adjoining open space. The latter space acts as an extension of temple activities and also as the shared space where communities come together for festivals and religious activities. The temple is the focal point for mountain communities and is located on higher grounds which makes them visible from a distance.

The village streets are generally narrow, at once public and yet appear to act as extension of private space of houses located along the edges. Although informal in origin, most settlements in the mountains reflect an underlying order in purpose and expression, an order that could not have been pre-planned but must have emerged as part of an incremental process of growth of settlements as a result of the continuing material practices and construction techniques.

Set amidst the backdrop of hills and snow-clad mountains, sweeping valleys, rivers, vegetation and forest cover that are bathed in every changing skies and light, human settlements in Himachal Pradesh appear to organically grow out of the folds of the landscape.

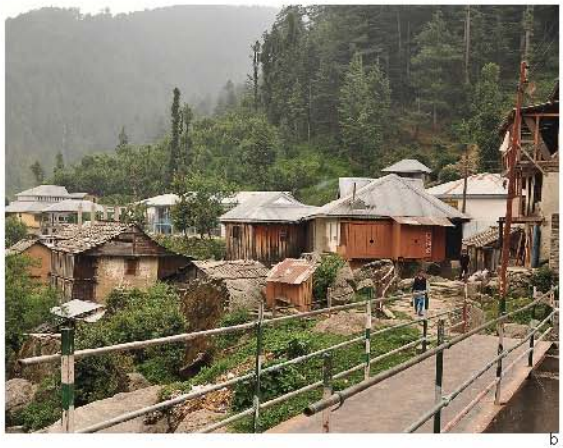
Padam Palace at Rampur



Stone temple at Balag

Twin tower temple at Sarahan (Chopal)

a



b

35(a-b). Typical houses in Sarahan with an indigenous water heater. a. House spills out onto the street with activities such as cleaning, washing and water heating; **b.** Wood-and-stone houses with metal roof are stacked sideways overlooking the valley.

Sarahan (Chopal)

Sarahan is one of the most beautiful villages in Chopal. Situated at an altitude of 2165 meters above sea level, Sarahan is located 26 kilometres from Chopal and 136 kilometres from Shimla. The village has many interesting wooden houses constructed using the traditional wood-and-stone *kath-khuni* techniques typical of the region with roofs mostly covered in metal sheets or slate stone.

A narrow winding trek from the village leads up to the famous religious circuit frequented by worshippers. Another trail goes over the bridge and leads to one of the most magnificent temple complexes with dual towers.

Bijjat *Devata* Temple

The main gate capped by two near identical towers leads to the inner courtyard. The older tower is reached by a notched wooden log; the other tower is accessible by a series of steps and houses the image of Bijjat Maharaj *Devata* on the top floor. This is among the few tower temples where outsiders

36. Bijjat *Devata* Tower Temple. Panoramic view from the courtyard of the temple complex; the upper level *verandah* runs all around the structure.

Image-based 3D reconstruction

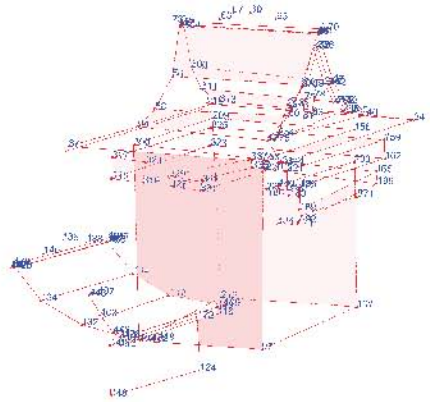
Photographic images record information visible along a cone of vision projected out from a point. Using this information and mathematical techniques of projective techniques, it is possible to reconstruct a three dimensional scene including size and location of elements in the scene. This process of image-based reconstruction is well advanced by now and can be used to obtain fairly accurate geometric data to reconstruct building geometries. These new techniques can supplement traditional on-the-ground measure drawings and in some cases may be the only option for generating as-built information since some buildings may be hard to access or difficult to measure.

Keeping in mind the relative difficulties in measuring and accessing many indigenous buildings in Himachal Pradesh, we collected visual records of many buildings in the form of images during our fieldwork. These images were then post-processed after the fieldwork travels using software-based image reconstruction techniques and are described in the following.

The image-based 3D reconstruction process requires an initial set of images that includes all relevant and significant details of interest for reconstruction. It is important to acquire images so that key points of interest are visible in more than one image and from different orientations. For architectural reconstructions of simple cubic volumes, for example, it is useful to take images that show side views (like elevations) together with corner views which show two or more adjoining building surfaces. Where possible, a series of images that completely cover the entire building envelope from surrounding viewpoints is useful for complete and accurate geometry reconstruction.

77. *Kath-khuni* building images from multiple view points. In order to create 3D reconstruction, images from side views and corner views are most useful.

Although it is possible to apply some of the geometric refinements and units of measurement in reconstruction software directly, we export reconstructed geometric data to three-dimensional modelling software. These packages allow more sophisticated control and adjustment of geometric elements. For example, reconstructed model may need slight adjustment of vertices so that all defining vertices of a quadrilateral surface lie in one plane (i.e. on a planar surface without any bends or kinks from edge to edge). The final refined model can then be used for diverse purposes including interactive walkthroughs of reconstructed scenes, preparation of animation sequences, simulation of construction processes, and many others.



83. Adjustments of reconstructed geometry in 3D modeller.

84. Final reconstructed 3D model of Tower Temple at Pujarli 7. This is the final 3D model with texture-mapped on all surfaces.

An empirical building technique: *Kath-khuni*

a

b

88(a-b). Examples of *kath-khuni* corner junctions. a. Wall corner of Bara-kila tower temple at Chitkul; **b.** Corner junction of a house in Gavas.

The state of Himachal Pradesh ranges in elevation from about 350 meters to nearly 7,000 meters above sea level. The region extends from the Shivalik range (which is the lesser Himalayas) to the Greater Himalayas in the Northern zone. Despite its varying topography, the region displays a relative consistency and homogeneity of traditional construction and use of materials with slight variations. In the mid and central Himalayas, a particular construction technique is extensively developed and used. Locally known as the *kath-khuni* (wood-and-stone) construction, it is especially visible in Kullu and Mandi districts and parts of Shimla, Kinnaur and Solan districts.

The origin of this term are explained by O. C. Handa (2008) as "..combination of two local terms: *kath* and *kuni*. The word *kath* is a dialectal variation of the Sanskrit word *kashtth*, which means wood, and *kuni* is again a dialectal variation of the Sanskrit word *kona*, that is, an angle or a corner. Obviously, the *kath-khuni* wall implies that it should have only wood on its corners or angles".

There are several regional variations of the word *kath-khuni* from region to region. In Sarahan (Chopal) region, it is known as *katth ki kanni* (corner); in other places, it is known as *kashth* (wood) *kona* (corner).

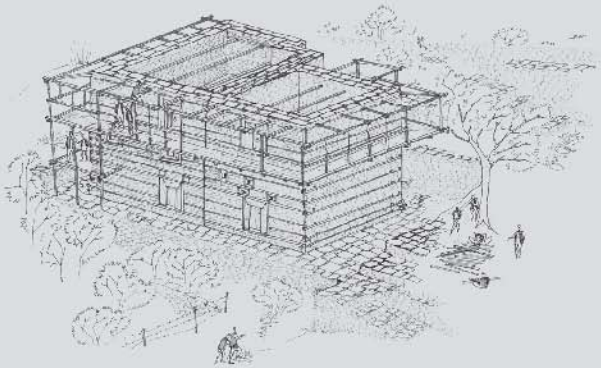
The widespread technique of *kath-khuni* construction can be found in buildings of various scales, from quite large *darbargadhs* and *kots* (princely homes and forts), to intricate and majestic temples, to modest houses and even small standalone structures like granaries in Himachal Pradesh. With its characteristic layered courses of wood-and-stone topped off by slate roofs, the *kath-khuni* buildings are easily recognizable.

Some houses and temples built using *kath-khuni* technique are decades or perhaps centuries old and are still stable and solid against all types of seismic and climatic forces. These buildings incorporate particular plan shapes and structural configurations together with use of locally available building materials and details. They illustrate remarkable insights of traditional construction and indigenous knowledge. The basic construction system draws upon knowledge inherited from generation to generation and extended over centuries. It is a very refined consequence of detailing through gradual empirical

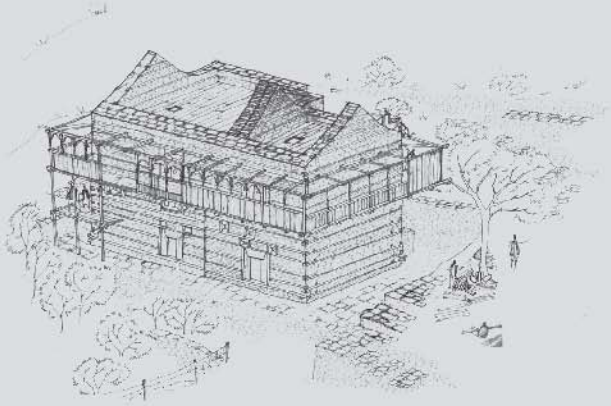
101. *Kath-khuni* wall construction. Dry masonry wood-and-stone wall of a temple under construction in Devidhar. This infill is filled with stone rubble.

pins. The outer faces of the wall as well as the corner often have specially shaped large stone pieces at the corner. This piece apart from protecting the wood also, according to local beliefs, helps toward off evil. When the solid load bearing walls are built above the plinth level, the stone pieces are arranged in an alternating manner strengthening the corners with staggered joints, both diagonally and laterally imparting strength. As the wall rises up, the height of the stone layer decreases and ultimately it is only the wood beams stacked on top of each other with an upper wooden structure.

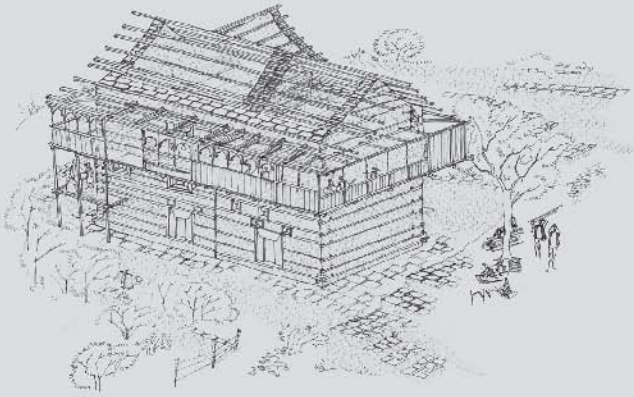
The framework of this wood-and-stone wall is the key characteristic of *kath-khuni* construction. This method of non-rigid framework and dry masonry construction helps in dissipating energy during earthquake and ground movements.



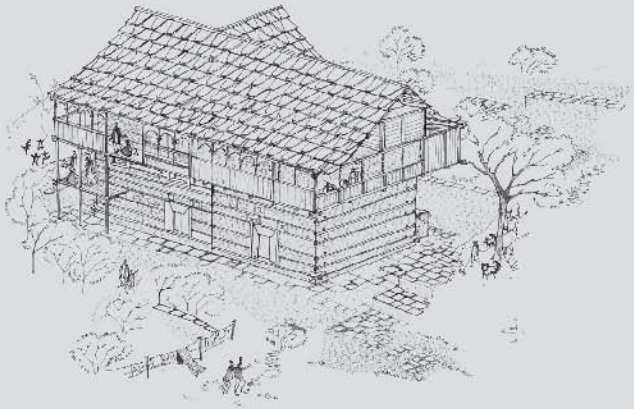
Stage 9: Top floor with balcony
Once the walls of the top floor are done, balcony and floor joists are laid again to complete the floor. The balcony is simultaneously completed. The walls are further extended till the attic space.



Stage 10: Roof structure
The walls of the top floor are extended so that the wooden members of the roof can be laid. They are built in triangular shape following the intended roof profile. The attic space is used for storage or as a kitchen so the smoke can escape from the roof.



Stage 11: Fixing the roof structure
Wooden members are placed on the wall and the ridge beam which is a single piece tree trunk is then raised to apex of the house before slate stones are placed on top.



Stage 12: Roof
Finally the slate stones are laid on the wooden members, the *devata* is invoked and the *puja* is performed before residents occupy the house.

a

b

c

132(a-c). Tower temples. Tower with a square base and cantilevered upper storey built in *kath-khuni* fashion are typical to western Himalayas. The deity is placed at the highest level at the top, the other floors are used to store grain for the *pujari* and for the villagers. **a.** Temple at Balag; **b.** Temple at Chopal; **c.** Temple at Pujarli 7.

Tower temples

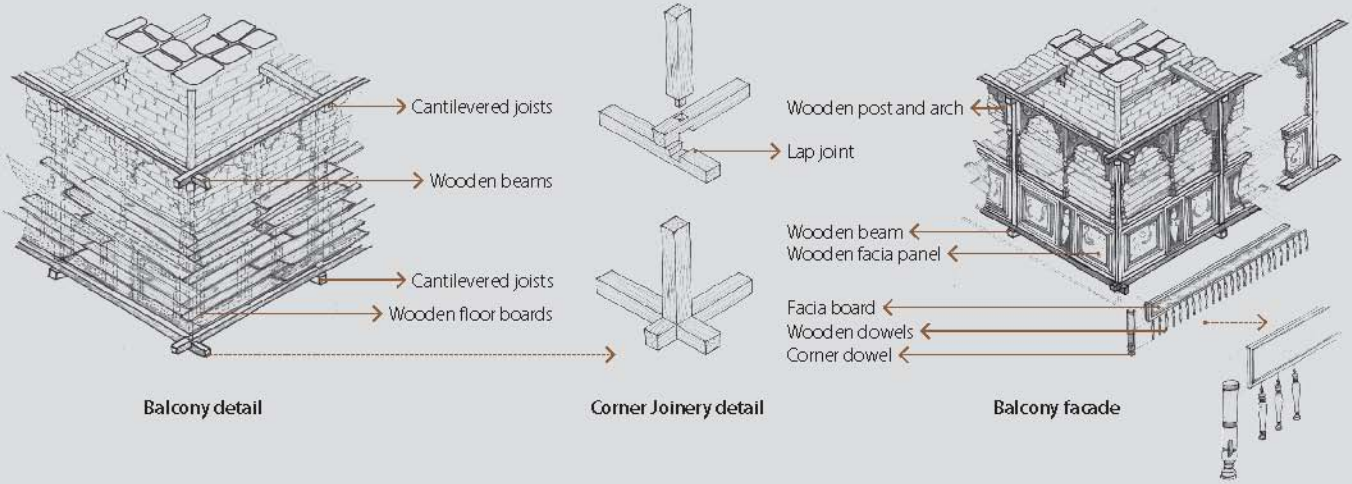
Towers with a cantilevered upper storey are commonly found in the western Himalayas. These tower type structures – some intended from the beginning as temples, also functioned as fortified dwellings, defence towers and observation stations during wars. The tall towers, some up to 7 to 9 storeys high, offered a commanding view of the landscape. Defence was a constant preoccupation with many principalities scattered among valleys and mountains. Therefore many of these towers feature a single small entry door at first floor which can be entered only through a ladder and each subsequent floor may be connected by a retractable notched tree trunk functioning as a staircase.

Since lower floors are susceptible to attacks, these structures often had projecting floors only at the highest level. Within the structure, the uppermost storey is also the most habitable because of adequate light and ventilation offered by timber projections on all sides; it was also the safest in terms of defence and comfortable for prolonged periods of use. Because of these reasons the highest level was later to be associated with control and power. It also offered a commanding view of the landscape.

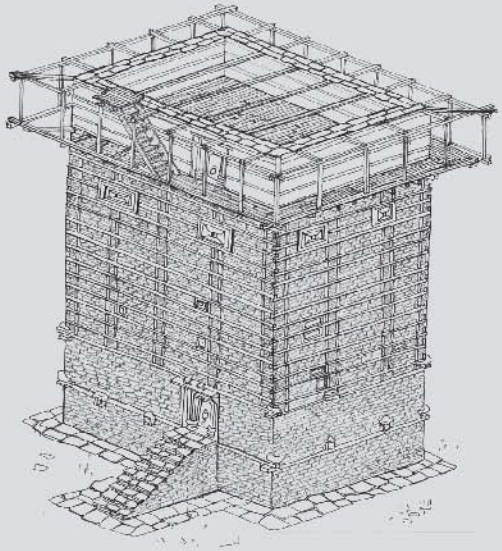
Such towers serve also as temple structures to house the deities. The top storey serves as the sanctorum and is typically the most profusely engraved in wood. The upper most storeys also provided complete isolation to the *pujari* of the temple for meditation and rest. Other than the *pujari* only members of the erstwhile ruling families are allowed inside the tower. The subsequent floors served as repositories for provisions and grain. These towers are also known as *bhandars* (storehouses) and often used as a treasury of the village *devata*.

Orientation

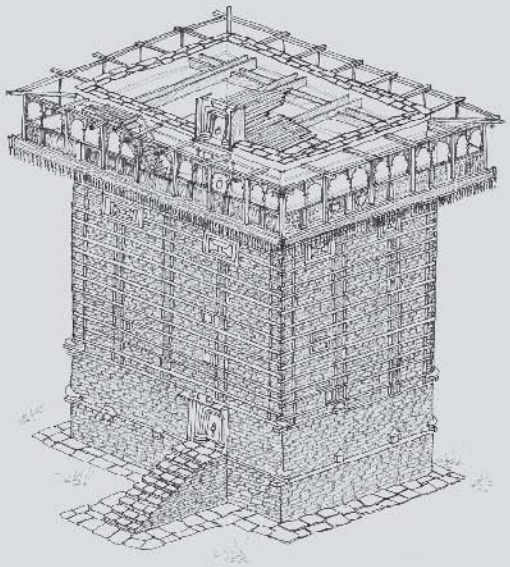
The four main sides of temples generally align with the four cardinal directions. Entrance is typically from the east and accessible by going up a notched ladder. Once inside, the prayer is directed to the gods facing east.



Balcony detail **Corner Joinery detail** **Balcony facade**



Projecting balcony
This balcony encircles the entire floor and acts as a circumambulating path. An elaborately carved door connects the spaces. The projecting cantilever joists are tied with vertical wooden posts.



Projecting balcony and adjacent floor
The balcony facade is enriched by a series of cusped arched opening. Elaborate carving is found on the wooden parapet panels. These usually feature folk and mythical stories .

The very constraints on availability of limited local materials in a demanding environment may have led to gradual evolution of indigenous building techniques. This is architecture of the effective use of resources at hand in the most meaningful way without being wasteful. It is hardly surprising that indigenous construction practices in Himachal Pradesh reflect the following key tenets of sustainable design in the widest possible sense.

Time and resource efficiency

The indigenous techniques primarily use wood and stone, two materials that are close at hand, together with rubble as an alternative to slow setting mortar. This results in use of resources at hand instead of use of materials produced, processed and moved from outside the local region.

Design efficiencies

Walls of considerable thinner section than the normal stone wall can be made using *kath-khuni* construction techniques with the net result that maximum height can be achieved with minimum material.

Built form and climate

Locally sourced raw materials such as stone, wood and slate offer better performance in terms of local climatic conditions. The infill rubble traps air within the walls creating an insulation zone. This prevents heat loss during the cold winters, keeps the interiors spaces warm and allows them to remain cool during the hot summers.

Energy efficient configuration and elements

The house form follows cuboidal stacking aligned to contours. The longer sides face south to fetch maximum sunlight which keeps the interiors warm and facilitates natural light throughout the day. Cattle are kept at the ground floor and the body heat emitted from them drifts up and warms the upper floors. The steeper slope of the roof allows snow to fall off whereas the flatter part at the end of the roof holds some snow which then acts as an insulation layer.

Structural resilience

Kath-khuni construction techniques are tested time and again and demonstrate superior resilience against earthquakes unlike structures dependent on non-local materials and rigid construction techniques.

Low maintenance

The traditional buildings and construction techniques require very low effort and skills to maintain and repair. There have been instances when tremors dislodged stones from the frame which later on only needed to be hammered back into the intact mesh of the house.

Resource reuse

There is rarely any wastage of materials since construction techniques involve use of both unfinished and finished materials which do not deteriorate over time and that can also be reused elsewhere.

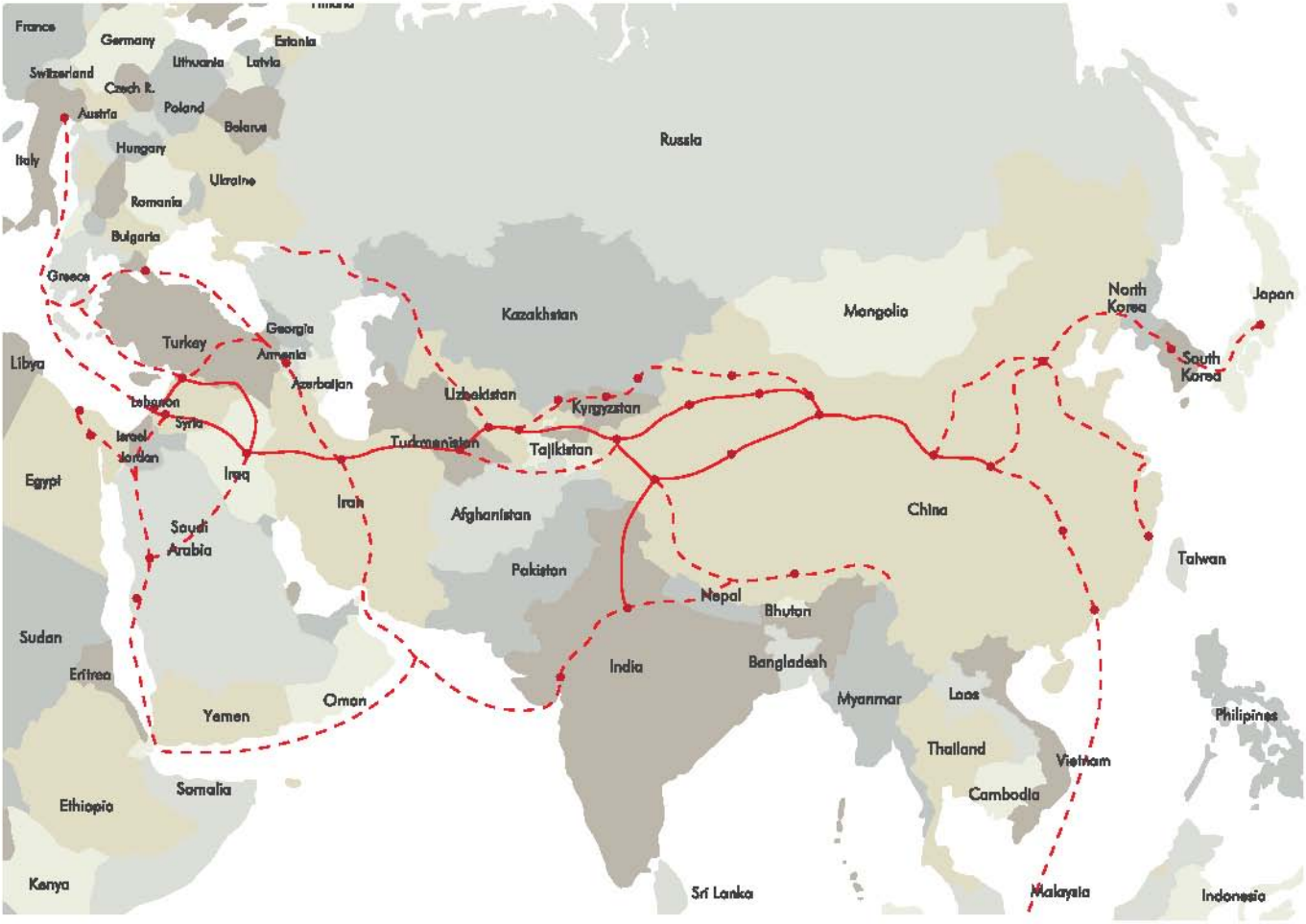
Biodegradable materials

Construction of vernacular houses revolves around naturally biodegradable materials with very limited use of metal or no fixating agents like mortar or any other synthetic materials.

Integration of material and symbolic capital

The concept of the community building is very commonly observed in temple construction, where entire community devotes various resources (monetary, material, time, etc.) towards its construction. A very similar process on smaller scale is observed in building of houses, where the extended family plays an important role in its construction. These traditions add to the community's sense of belonging, bonding and ownership in the building and its practices.

Related building practices



165. Map of the Silk Route. The present day Hindustan-Tibet road (National Highway 22) that passes through Himachal Pradesh follows an old trade route that branched down from the famous Silk Route into India. *Source: http://virtuallabs.stanford.edu/silkroad/SilkRoad.html.*

In Himachal Pradesh, wood, slate, stone, mud, and bamboo and many other materials are used in traditional architecture. The focus in our research was on one specific construction technique called *kath-khuni* which involves the use of wood and stone to build earthquake resistant structures. This construction technique is complementary to many other equally interesting techniques that are found throughout the Himalayan mountain settlements. Such techniques range from *taq* and *dhajji-dewari* in Kashmir and Himachal Pradesh, *Koti-banal* in Uttrakhand, *bhatar* in Pakistan and its variations found in the regions spanning from Nuristan to Baltistan in Afghanistan, to the trabeated wood-and-stone houses popular in the far east Himalayan region of Bhutan and Sikkim.

176. The team members with locals: left to right: Jay Thakkar, Mansi Shah, Vidyaratan (temple caretaker at Kamru fort), Tarang Sagara, Bharat Dave, Anup Singh.